SpinLauncher

Jonas, Ruven, Mara

Background & Project Goal

Status quo at the time:

- Launch pad at a distance of 0.1 m in front of the goal
- Velocity: not explicitly defined
- no spin of puck

Goals:

- Puck shooter:
  - Velocities up to 150 km/h
  - Adjustable and automized
  - Spin of puck
- Experiment:
  - Repeatability
  - Velocity
  - Spin of puck

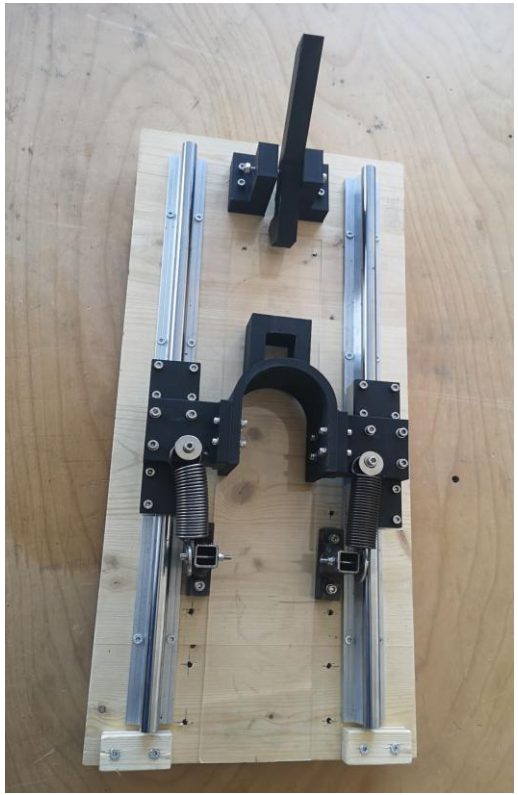


Fig. 1: Launch pad

Research Question

The aim of this project was to

1. **develop a new launching system and**
2. **How consistent and stable is the hockey puck behaviour produced by the new developed puck launching system (SpinLauncher), specifically regarding trajectory accuracy, velocity and spin?**

Decision Matrix

	Catapult	Spin Launch	Springs	2-3 Wheels	Railgun	Free Fall - Gravity	10 Wheels
Complexity	5	4	4	5	10	1	7
Spin	3	3	10	1	8	7	1
Velocity	5	1	9	4	1	7	3
Size	7	5	2	2	5	10	4
Complexity Release Mechanism	2	4	2	1	3	1	1
Repeatability	2	1	1	4	1	4	3
Feasibility	6	3	2	3	10	2	4
Sum	30	21	30	20	38	32	23

SpinLauncher - Block diagram

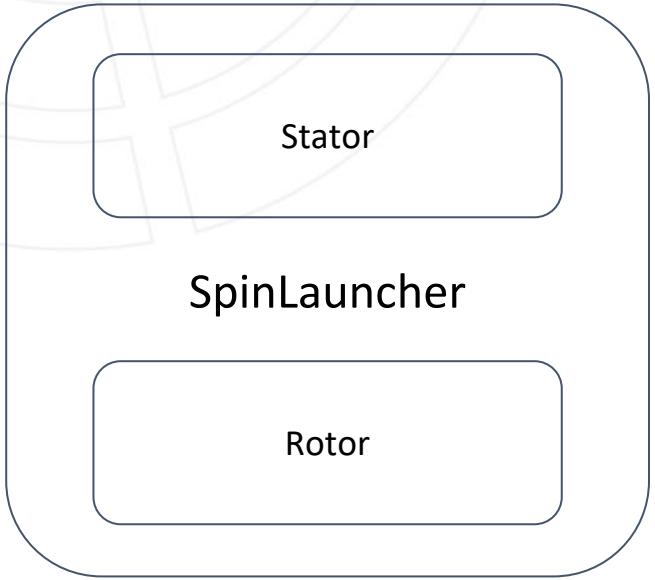


Fig. 2: SpinLauncher block diagram

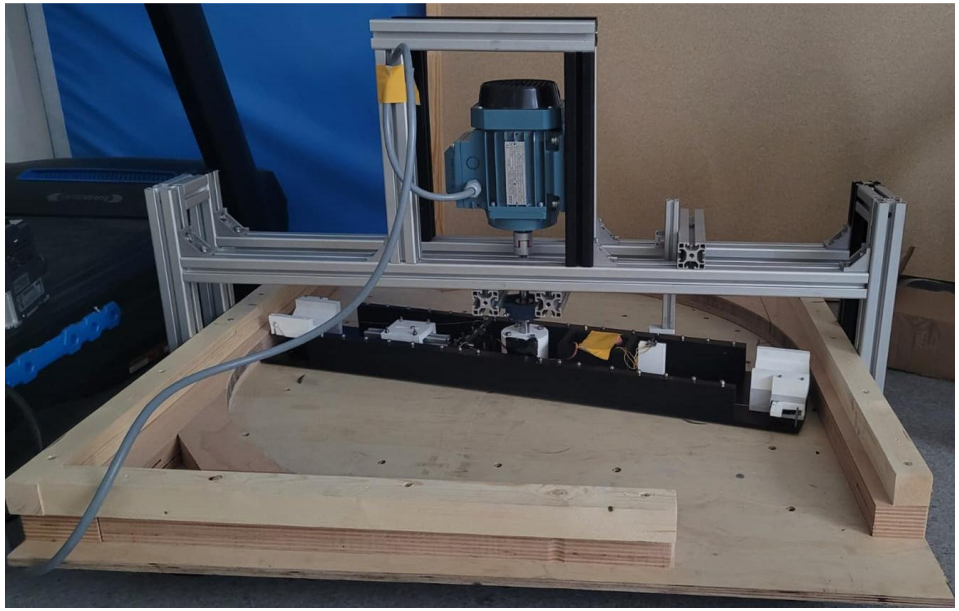


Fig. 3 : SpinLauncher

SpinLauncher - Stator

- ITEM frame
- wood boundaries
- Bearings
- 3 Phase asynchronous motor
- 1 Phase AC frequency converter

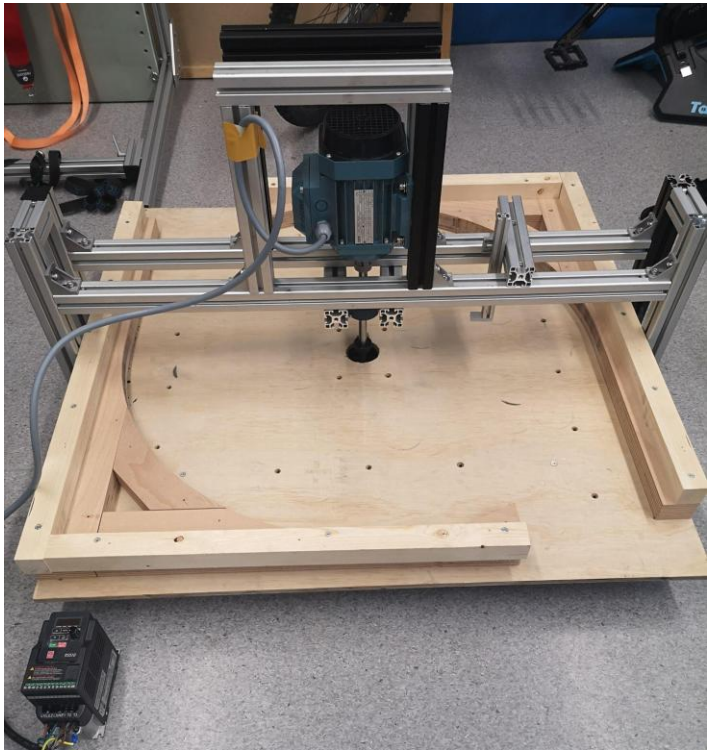


Fig. 4: SpinLauncher - Stator

SpinLauncher - Rotor

- wood construction
- 2x release mechanism
- Counterweight
- Servo motor
- µC
- Battery
- Hall effect sensor

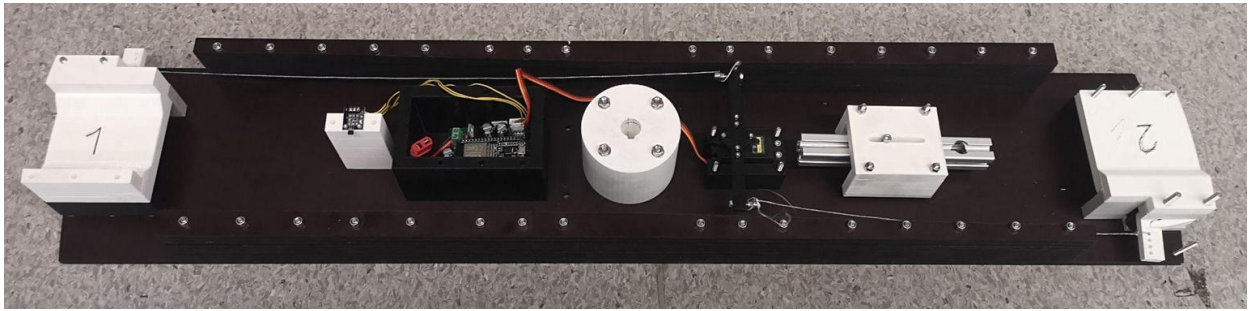


Fig. 5: SpinLauncher - Rotor

Electronic Block Diagram

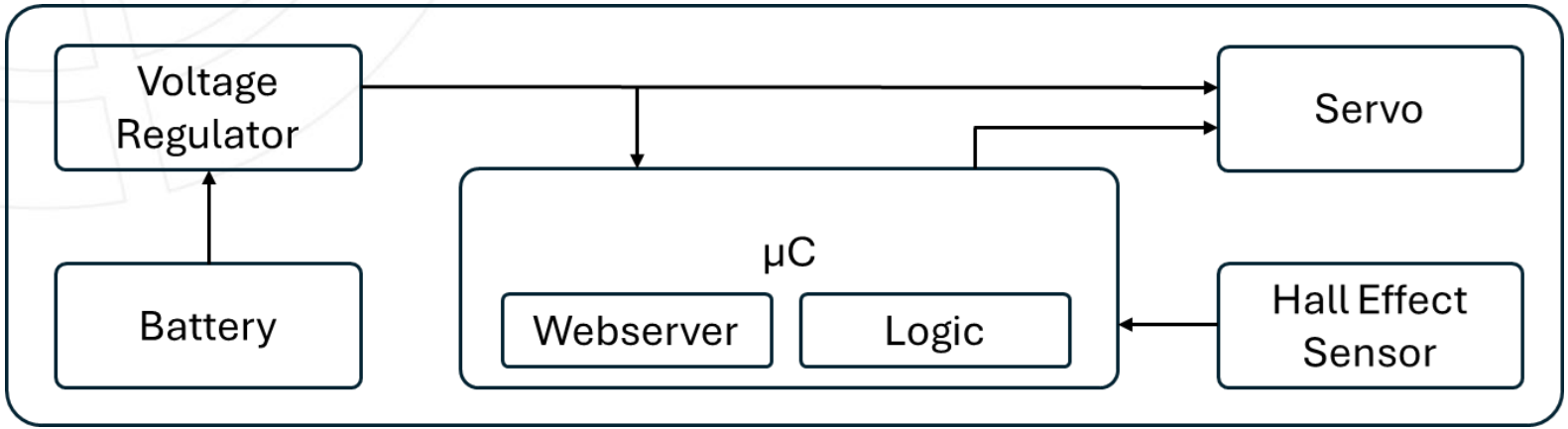


Fig. 6: Block diagram of electronic on Rotor

Release Mechanism Design

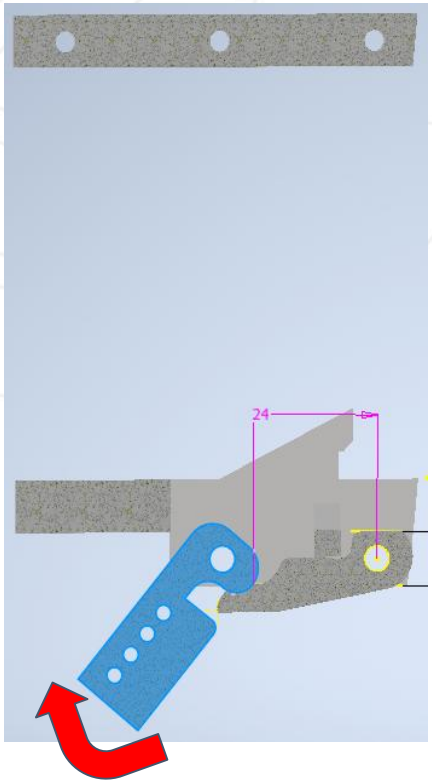


Fig. 8: half section view trigger pulles

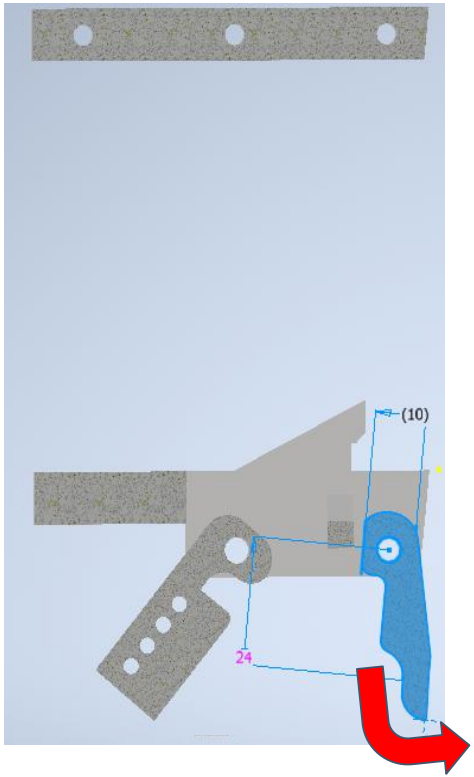


Fig. 9: release mechanism half section view

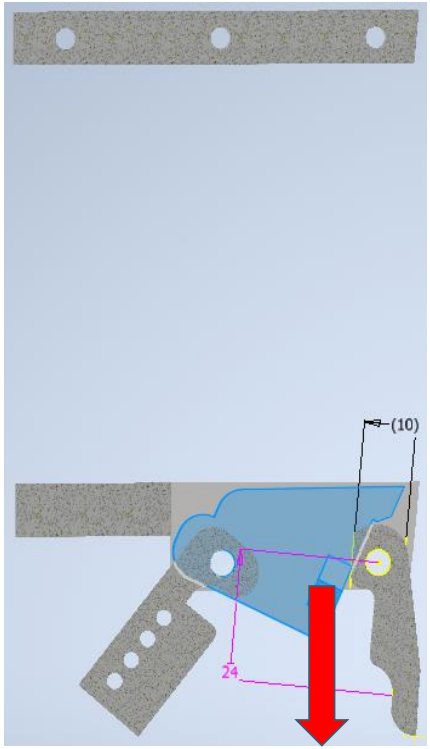


Fig. 10: half section view triangle pushed back

Experimental Setup Schematic

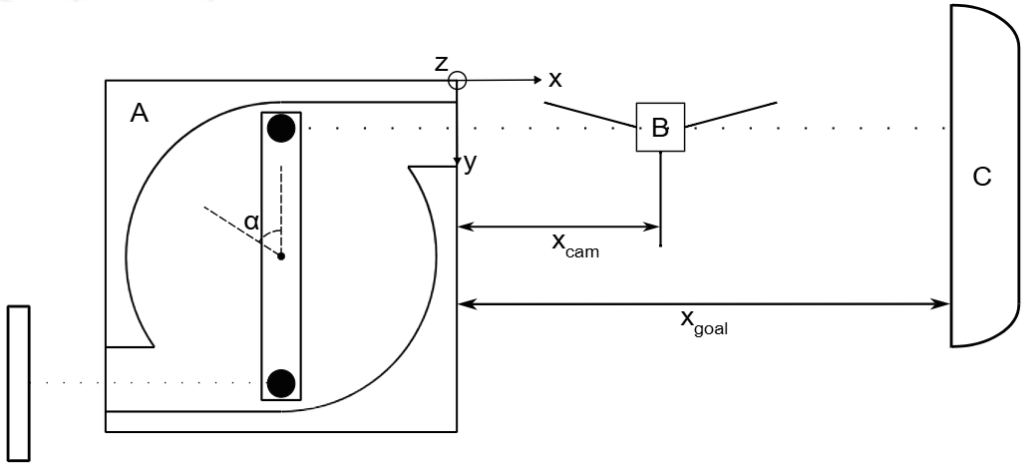


Fig. 11: Top view of the experimental setup

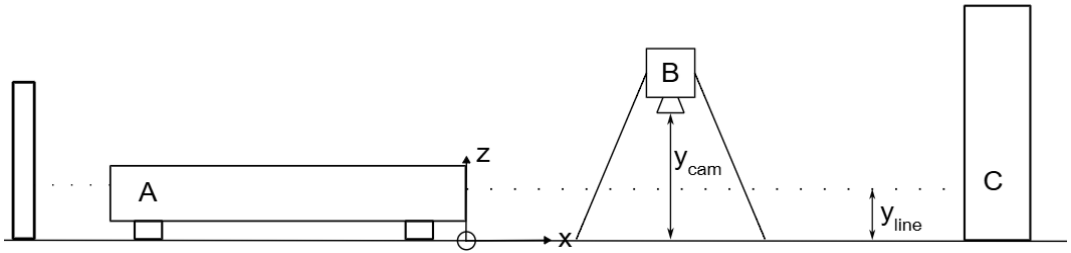


Fig. 12: Side view of the experimental setup

x_goal = 1.5 m

x_cam = 0.2 m

A … SpinLauncher

B … High Speed Camera

C … Goal

y_line = 6.5 cm

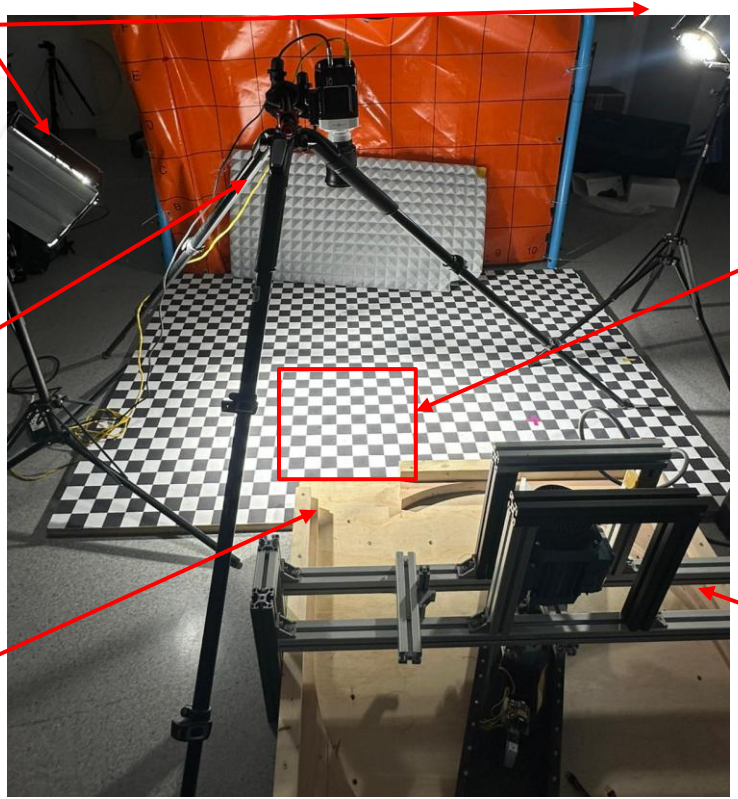
y_cam = 98.5 cm

Experimental Setup

Illumination

High-speed camera

Horizontal puck launch direction



Analysis focused on initial puck motion after release

SpinLauncher

Fig. 13: Experimental Setup

High Speed Camera Settings

- Bit depth: 12
- Resolution: 1280 x 800
- Sample rate: 3200 fps
- Exposure time 310 µs
- Focus: manual
- Trigger:
  - Image-Based Auto-Trigger
  - placed at outlet of SpinLauncher

Fig. 14: PHANTOM MIRO M310

Experimental Parameters

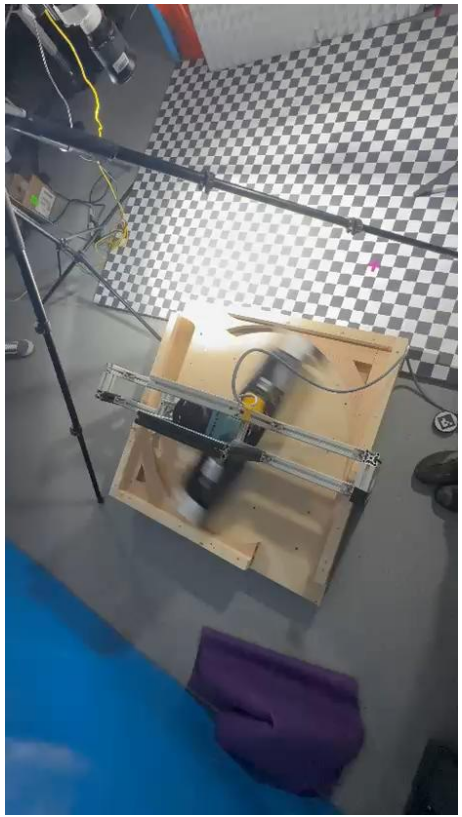
- Repetitions: 11
- Settings:

Velocity	25 km/h	45 km/h	55 km/h	65 km/h
RPM - ideal	166	299	365	431
RPM - real	167	298	369	-
Launch angle	20°	0°	0°	0°

The device broke down after the third run at 55 km/h. → no further tests

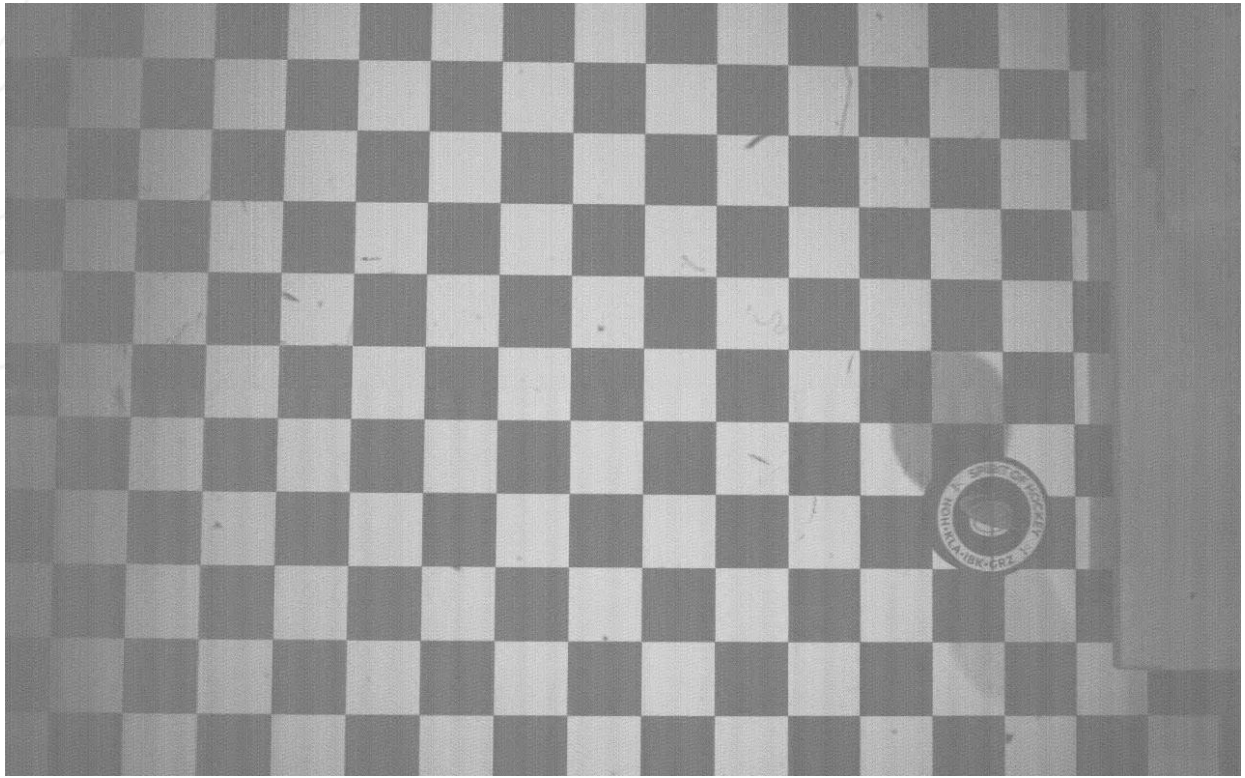
Test Run

Fig. 15: Webserver interface



Vid. 1: Test run

Experiment SlowMo Demo



Vid. 2: Slow motion demo flight of puck (25km/h)

Data Processing

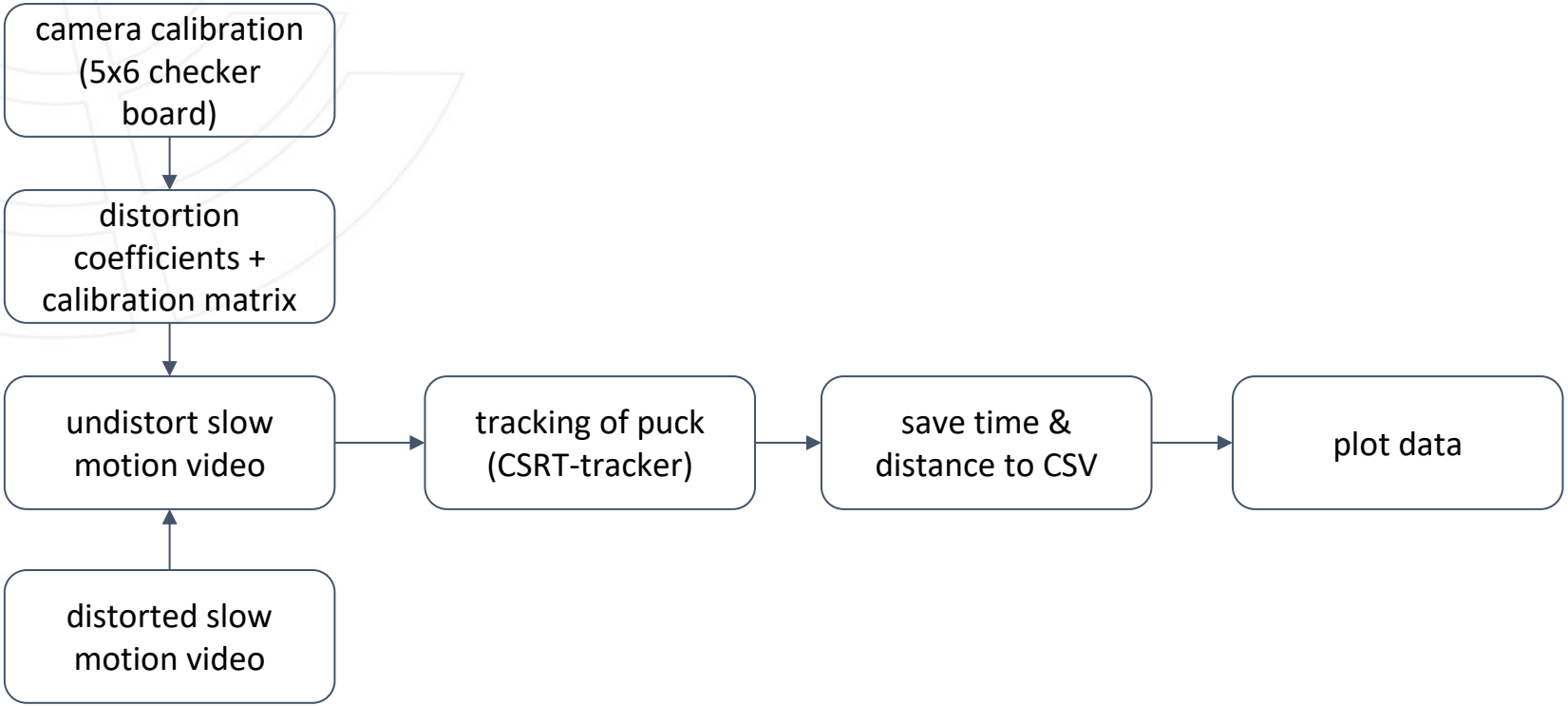
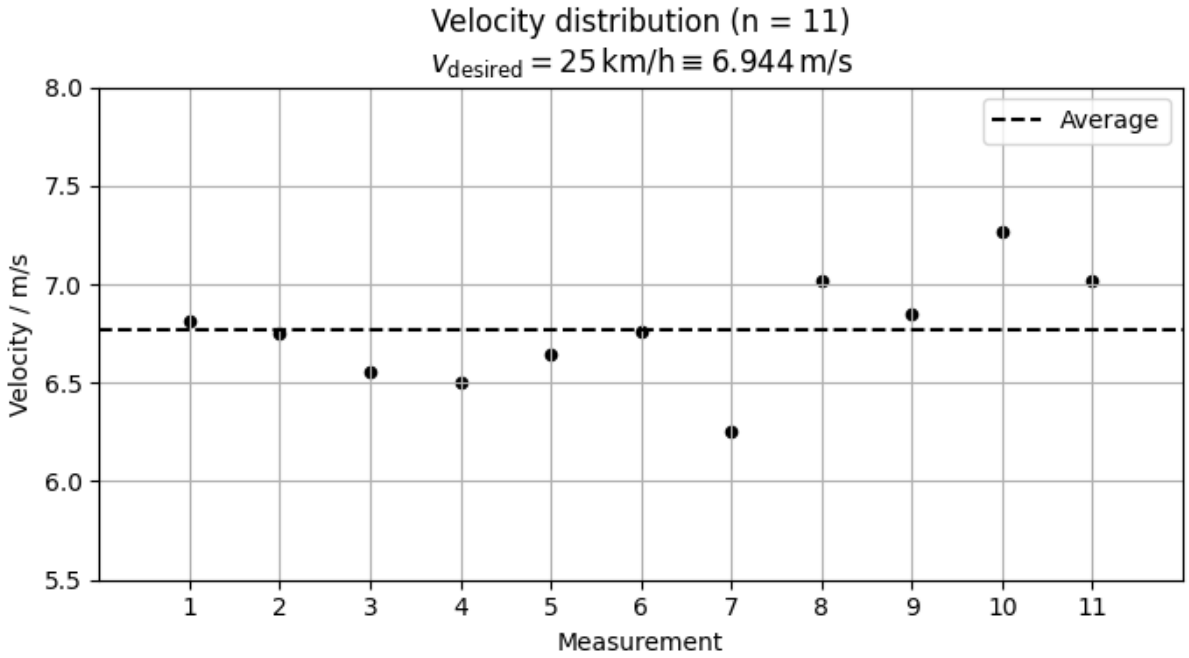


Fig. 16: Flowchart of data processing

Results: 25 km/h

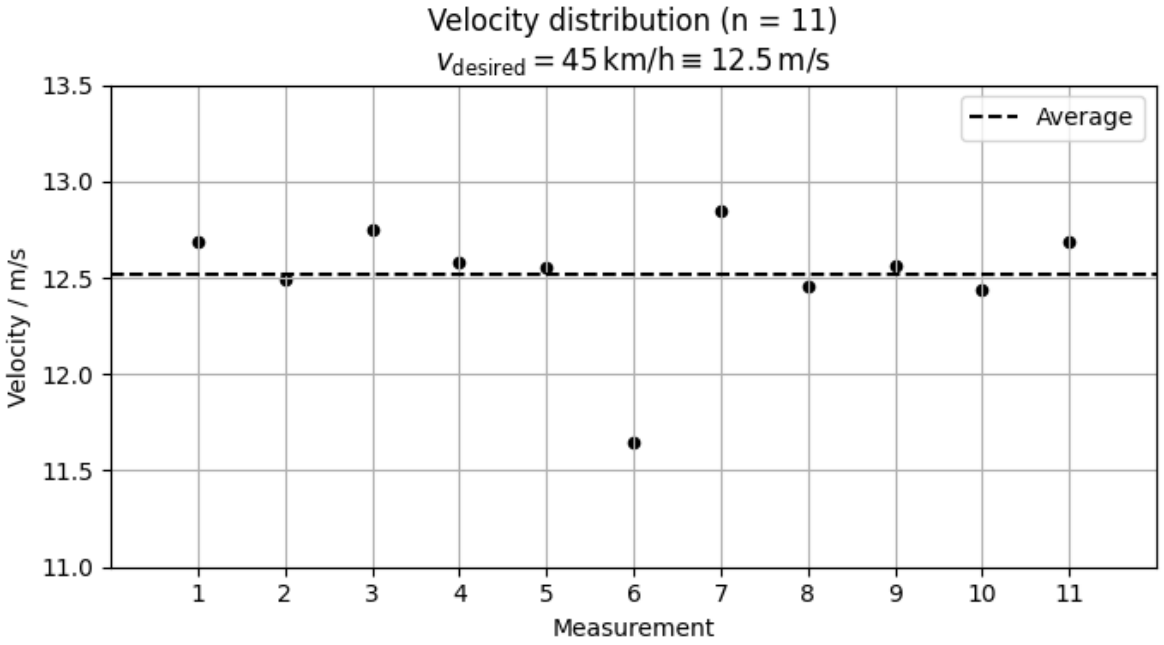


Mean value:
- 24.36 km/h

Standard deviation:
- 1.00 km/h

Fig. 17: Scatter plot of velocity distribution for 25 km/h target velocity

Results: 45 km/h



Mean value:
- 45.07 km/h

Standard deviation:
- 1.14 km/h

Fig. 18: Scatter plot of velocity distribution for 45 km/h target velocity

Results: 55 km/h

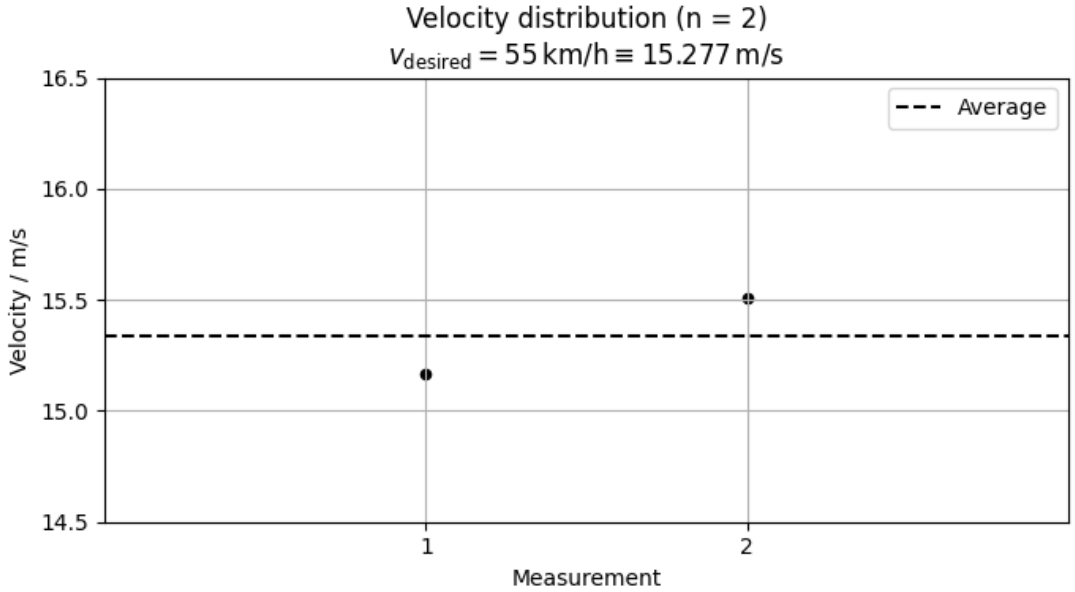


Fig. 19: Scatter plot of velocity distribution for 55 km/h target velocity

Mean value:
- 55.22 km/h

Standard deviation:
- 0.86 km/h

Only two valid measurements
→ No statistical evaluation possible, but it is still visible that the speed is approx. 55 km/h

Results: distance-time-diagram

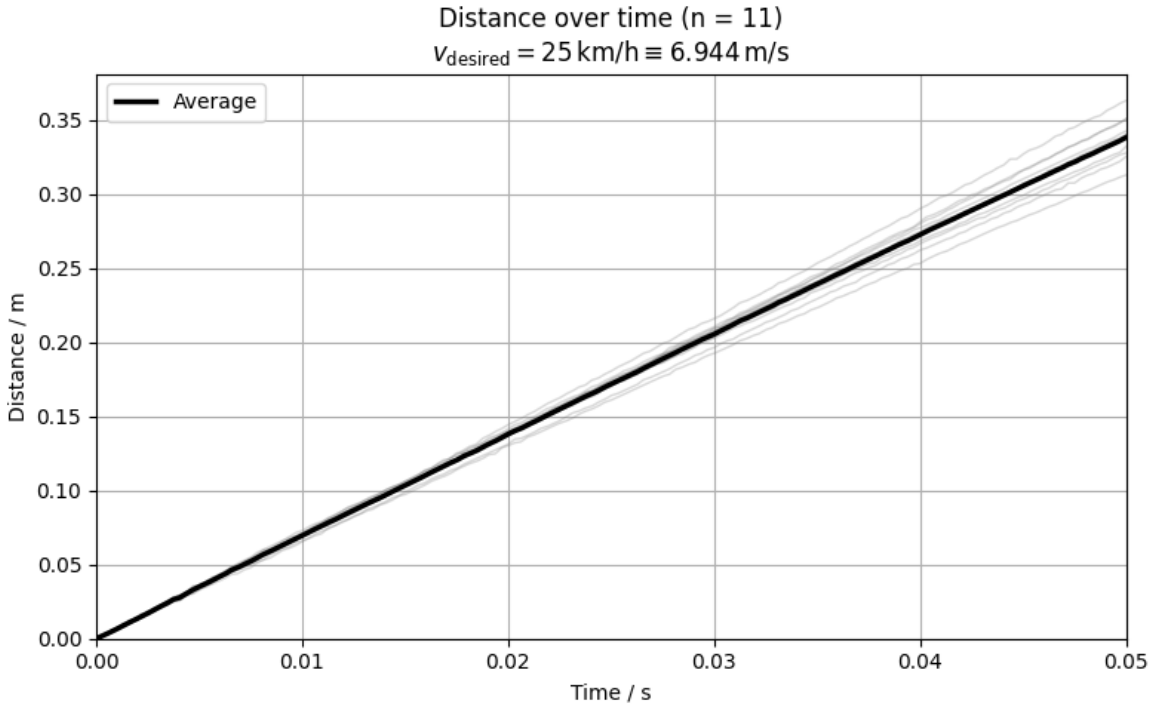
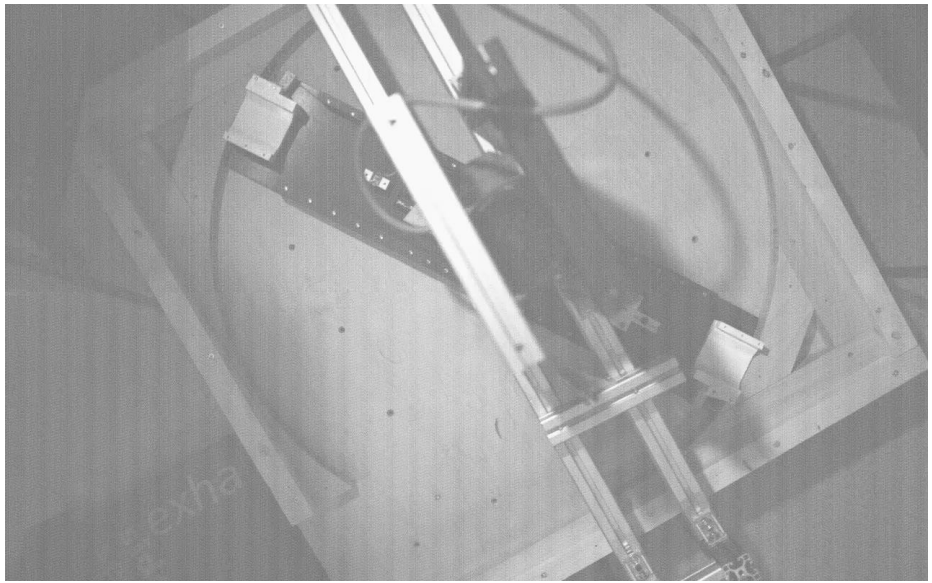


Fig. 20: Distance-time-plot for 25 km/h target velocity

Limitations and future work

- Manufacturing tolerances
- Release Mechanism
  - Cable pull
  - Flex of material
  - Servo actuation time
- communication FC and µC
- Tight schedule



Vid. 3: Limitation of the cable pull

Conclusion

Goals:

- Puck shooter:

Velocities up to 150 km/h	no → 55 km/h
Configurable and automized	yes
Spin	yes

- Experiment:

Velocity repeatable	yes
Spin repeatable	unknown

- majority of goals achieved
- higher speed than before
- improvement of Release Mechanism

Thank you for your Attention!

Jonas, Ruven, Mara

Documentation

- Github: https://github.com/egijo/SpinLauncher

- Notion: https://www.notion.so/mci-medtech/Hockey-PRO-28091a52c19480998451c0e8b286c635

Literature

Posch, M., Hockey PRO – Development of a Camera-Based Ice Hockey Shooting Training System, Master's Thesis, Management Center Innsbruck, 2024.

Electronic Schematic

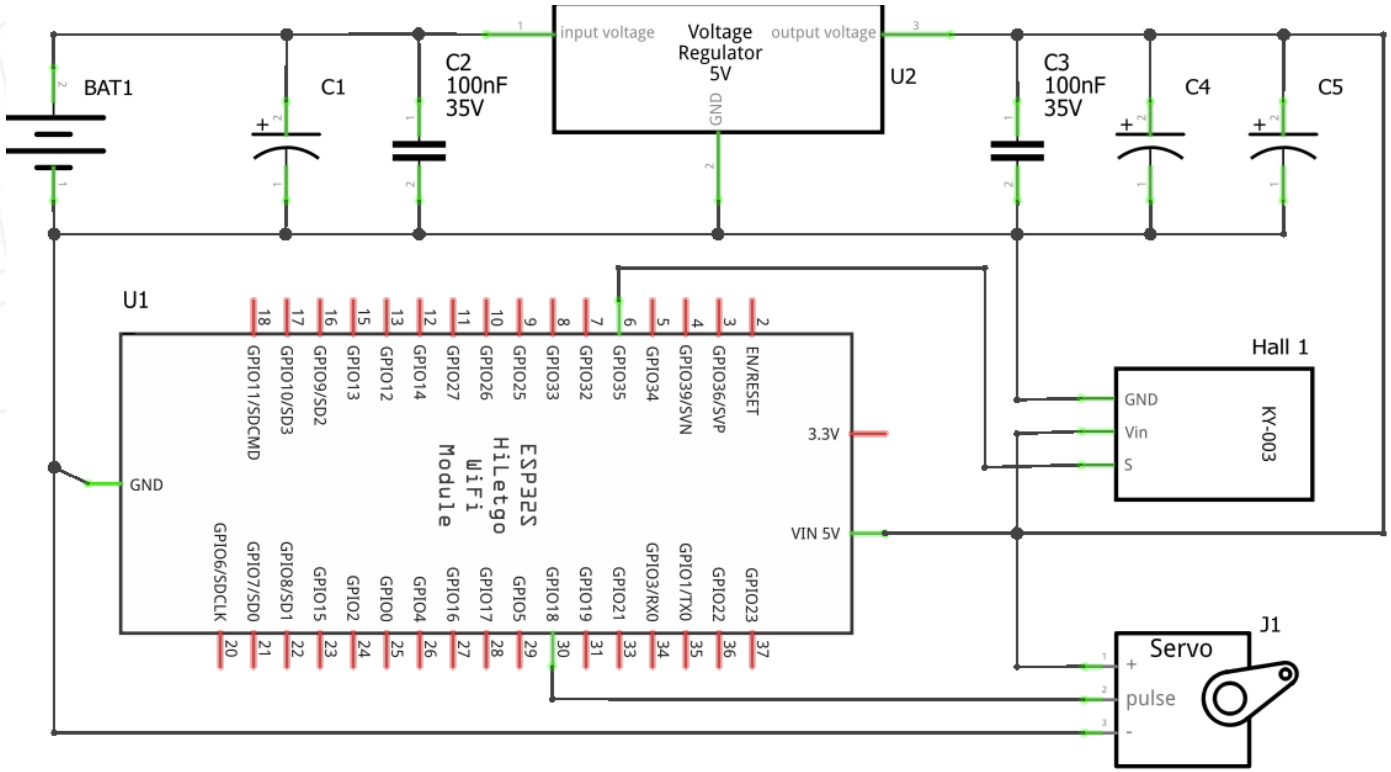


Fig. 20: Schematic of rotor electronic

3 Phase Motor Type Plate

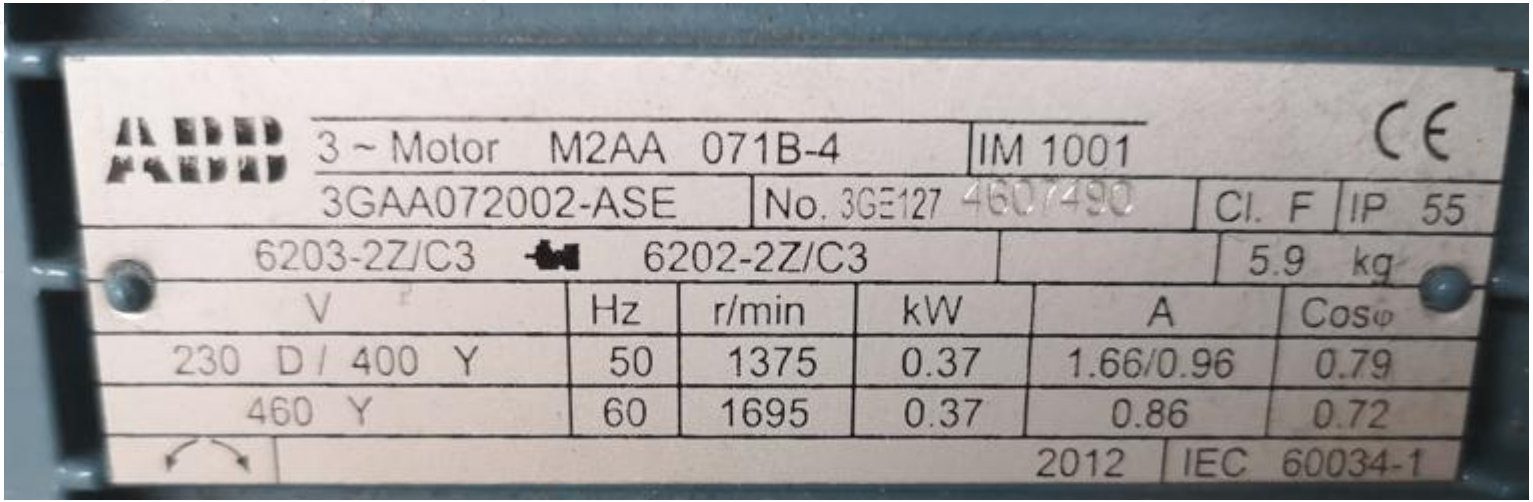


Fig. 21: Motor type plate

Frequency Converter Type Plate

Fig. 22: Frequency converter type plate

Results: distance-time-diagram 45 km/h

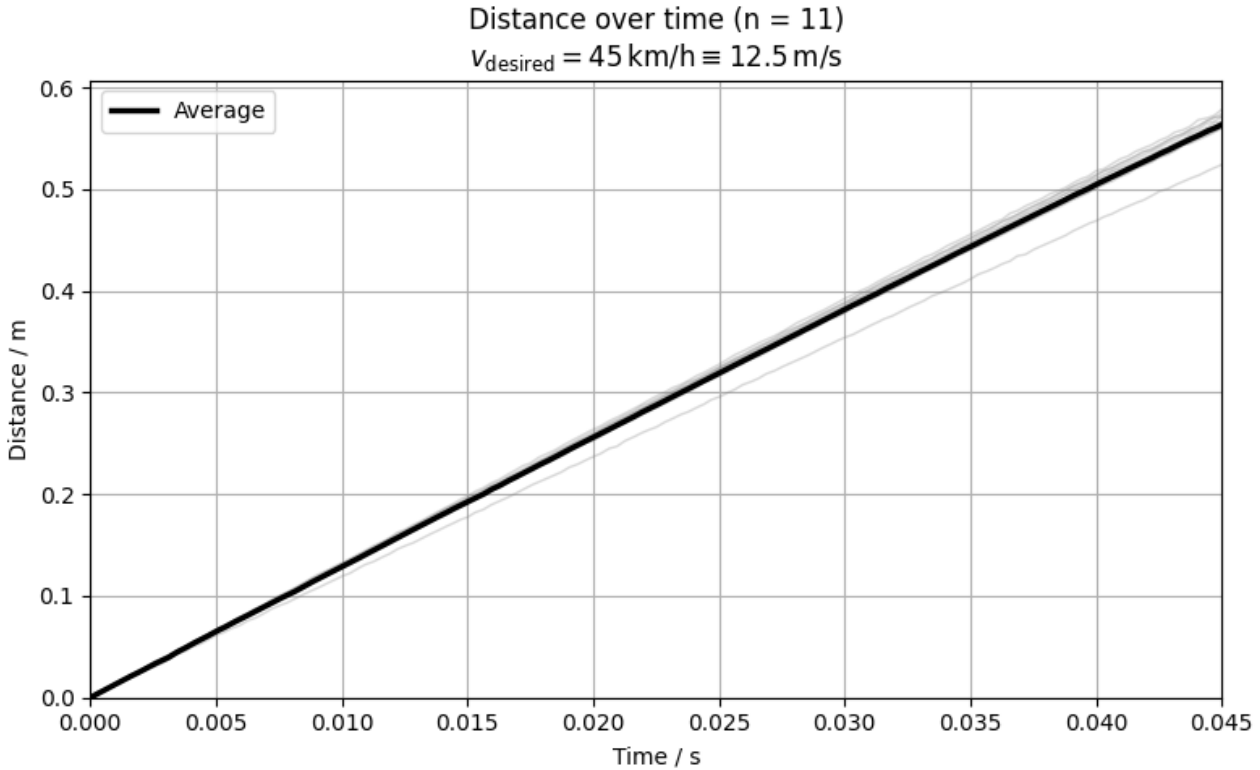


Fig. 23: Distance-time-plot for 45 km/h target velocity

Results: distance-time-diagram 55 km/h

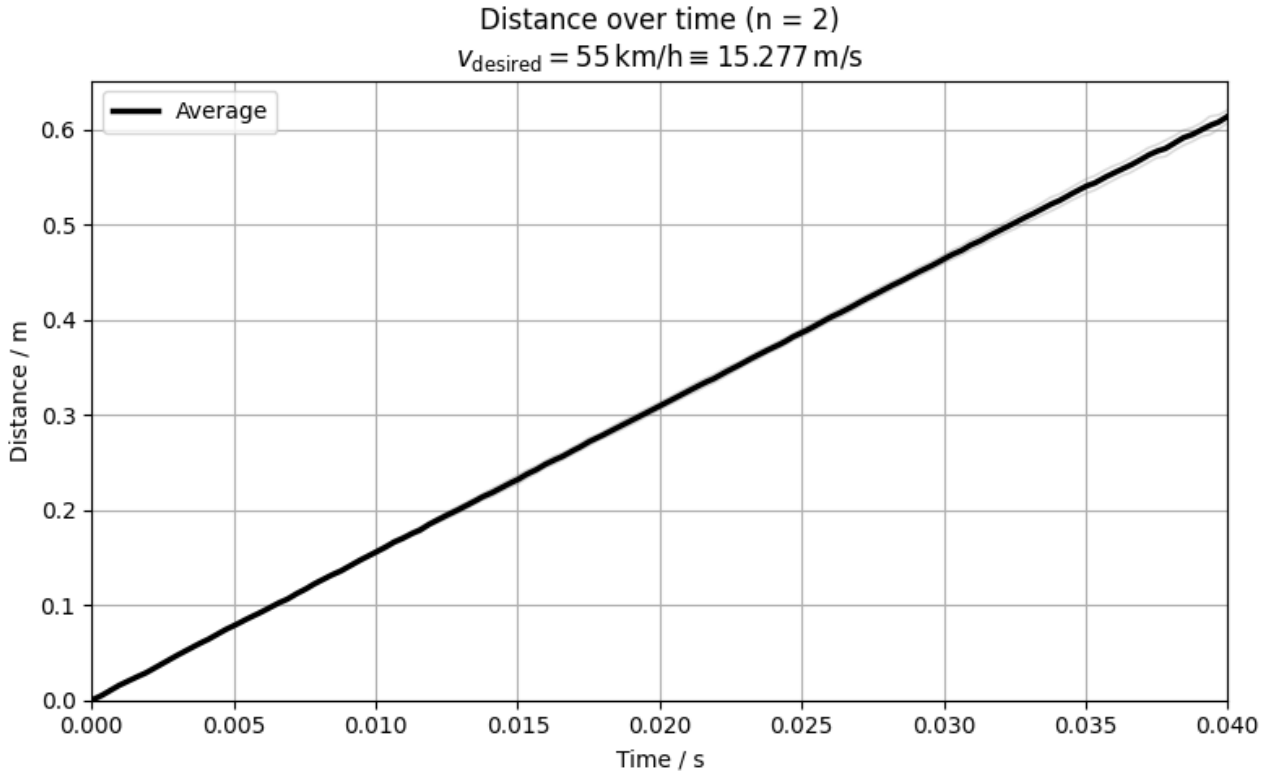


Fig. 24: Distance-time-plot for 55 km/h target velocity